CLAIMS

1. A process for displacing a moveable unit (4) on a base (2), said moveable unit (4) being displaced linearly according to a predetermined displacement under the action of a controllable force (F),

wherein:

a) equations are defined which:

– illustrate a dynamic model of a system formed by elements (2, 4, MA, MA1, MA2, MA3), of which said moveable unit (4) is one, which are brought into motion upon a displacement of said moveable unit (4); and

– comprise at least two variables, of which the position of said moveable unit (4) is one;

b) all the variables of this system, together with said force (F), are expressed as a function of one and the same intermediate variable y and of a specified number of derivatives as a function of time of this intermediate variable, said force (F) being such that, applied to said moveable unit (4), it displaces the latter according to said specified displacement and renders all the elements of said system immobile at the end of said displacement;

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c) the initial and final conditions of all said variables are determined;

d) the value as a function of time of said intermediate variable is determined from the expressions for the variables defined in step b) and said initial and final conditions;

e) the value as a function of time of said force is calculated from the expression for the force, defined in step b) and said value of the intermediate variable, determined in step d); and

f) the value thus calculated of said force (F) is applied to said moveable unit (4).

2. The process as claimed in claim 1, wherein, in step a), the following operations are carried out: the variables of the system are denoted xi, i going from 1 to p, p being an integer greater than or equal to 2, and the balance of the forces and of the moments is expressed, approximating to first order if necessary, in the so-called polynomial matrix form:

$$A(s)X = bF$$

with:

- A(s) matrix of size p x p whose elements Aij(s) are polynomials of the variable s = d/dt;

- X the vector $\begin{pmatrix} x1 \\ \vdots \\ xp \end{pmatrix}$;

- b the vector of dimension p; and

- F the force exerted by a means of displacing the moveable unit and in that, in step b), the following operations are carried out:

– the different variables xi of said system, i going from 1 to p, each being required to satisfy a first expression of the form:

$$xi = \sum_{j=0}^{j=r} pi,j.y^{(j)} ,$$

the $y^{(j)}$ being the derivatives of order j of the intermediate variable y, r being a predetermined integer and the pi,j being parameters to be determined, a second expression is obtained by putting $y^{(j)}=s^j.y$:

$$xi = \left(\sum_{j=0}^{j=r} pi,j.s^j \right) y = Pi(s).y ,$$

– a third expression of vectorial type is defined on the basis of the second expressions relating to the different variables xi of the system (S1, S2):

$$X = P.y$$

comprising the vector $P = \begin{pmatrix} P1 \\ \vdots \\ Pp \end{pmatrix}$

- said vector P is calculated, by replacing X by the value P.y in the following system:

$$\begin{cases} B^T.A(s).P(s) = Op-1 \\ bp.F = \sum_{j=1}^{j=p} Ap,j(s).Pj(s).y \end{cases}$$

in which:

. B^T is the transpose of a matrix B of size px(p-1), such that B^Tb=Op-1;

. bp is the p-th component of the vector b previously defined; and

. Op-1 is a zero vector of dimension (p-1);

- the values of the different parameters pi,j are deduced from the value thus calculated of the vector P; and

- from these latter values are deduced the values of the variables xi as a function of the intermediate variable y and of its derivatives, on each occasion using the corresponding first expression.

3. The process as claimed in claim 1,

wherein, in step d), a polynomial expression for the intermediate variable y is used to determine the value of the latter.

4. The process as claimed in claim 3, wherein, the initial and final conditions of the different variables of the system, together with the expressions defined in step b), are used to determine the parameters of the polynomial expression for the intermediate variable y.

5. The process as claimed in claim 1 for displacing a moveable unit (4) on a base (2) which is mounted elastically with respect to the floor (S) and which may be subjected to linear and angular motions, wherein the variables of the system are the linear position x of the moveable unit, the linear position xB of the base and the angular position θz of the base, which satisfy the relations:

$$\begin{cases} x = y + \left(\frac{rB}{kB} + \frac{r\theta}{k\theta}\right) y^{(1)} + \left(\frac{mB}{kB} + \frac{rBr\theta}{kBk\theta} + \frac{J}{k\theta}\right) y^{(2)} + \left(\frac{rBJ}{kBk\theta} + \frac{mBr\theta}{kBk\theta}\right) y^{(3)} + \frac{mBJ}{kBk\theta} y^{(4)} \\ xB = -\frac{m}{kB}\left(\frac{J}{k\theta} y^{(4)} + \frac{r\theta}{k\theta} y^{(3)} + y^{(2)}\right) \\ \theta z = -d\frac{m}{k\theta}\left(\frac{mB}{kB} y^{(4)} + \frac{rB}{kB} y^{(3)} + y^{(2)}\right) \end{cases}$$

in which:

- m is the mass of the moveable unit;

- mB, kB, kθ, rB, rθ are respectively the mass, the linear stiffness, the torsional stiffness, the linear damping and the torsional damping of the base;

- J is the inertia of the base with respect to a vertical axis;

- d is the distance between the axis of translation of the center of mass of the moveable unit and that of the base; and

- $y^{(1)}$, $y^{(2)}$, $y^{(3)}$ and $y^{(4)}$ are respectively the first to fourth derivatives of the variable y.

6. The process as claimed in claim 1 for displacing on a base a moveable unit (4) on which are elastically mounted a number p of auxiliary masses MAi, p being greater than or equal to 1, i going from 1 to p,

wherein the variables of the system are the position x of the moveable unit (4) and the positions zi of the p auxiliary masses MAi, which satisfy the relations:

$$\begin{cases} x = \left(\prod_{i=1}^{p} \left(\frac{mi}{ki} s^2 + \frac{ri}{ki} s + 1 \right) \right) . y \\ zi = \left(\prod_{\substack{j=1 \\ j \neq i}}^{p} \left(\frac{mj}{kj} s^2 + \frac{rj}{kj} s + 1 \right) \right) . \left(\frac{ri}{ki} s + 1 \right) . y \end{cases}$$

in which:

- Π illustrates the product of the associated expressions;

- mi, zi, ki and ri are respectively the mass, the position, the stiffness and the damping of an auxiliary mass MAi;

- mj, kj and rj are respectively the mass, the stiffness and the damping of an auxiliary mass MAj; and

- s=d/dt.

7. The process as claimed in claim 1 for displacing a moveable unit (4) on a base (2) which is mounted elastically with respect to the floor (S) and on which is elastically mounted an auxiliary mass (MA), wherein the variables of the system are the positions x, xB and zA respectively of the moveable unit (4), of the base (2) and of the auxiliary mass (MA), which satisfy the relations:

$$\begin{cases} x = \left[(mAs^2 + rAs + kA).(mBs^2 + (rA + rB)s + (kA + kB)) - (rAs + kA)^2\right].y \\ xB = -My^{(2)} \\ zA = -M(rAy^{(3)} + kAy^{(2)}) \end{cases}$$

in which:

- M, mB and mA are the masses respectively of the moveable unit (4), of the base (2) and of the auxiliary mass (MA);

- rA and rB are the dampings respectively of the auxiliary mass (MA) and of the base (2);

- kA and kB are the stiffnesses respectively of the auxiliary mass (MA) and of the base (2); and

- s=d/dt.

8. The process as claimed in claim 1 for displacing on a base mounted elastically with respect to the floor, a moveable unit on which is elastically mounted an auxiliary mass,

wherein the variables of the system are the positions x, xB and zC respectively of the moveable unit, of the base and of the auxiliary mass, which satisfy the relations:

$$\begin{cases} x = \left[(mCs^2 + rCs + kC).(mBs^2 + rBs + kB\right].y \\ xB = \left[(mCs^2 + rCs + kC).(Ms^2 + rCs + kC) - (rCs + kC)^2\right].y \\ zC = (rCs + kC).(mBs^2 + rBs + kB).y \end{cases}$$

in which:

- M, mB and mC are the masses respectively of the moveable unit, of the base and of the auxiliary mass;

- rB and rC are the dampings respectively of the base and of the auxiliary mass;

- kB and kC are the stiffnesses respectively of the base and of the auxiliary mass; and

- s=d/dt.

9. A device comprising:

- a base (2);

- a moveable unit (4) which may be displaced linearly on said base (2); and

- a controllable actuator (5) able to apply a force (F) to said moveable unit (4) with a view to its displacement on said base (2),

wherein it furthermore comprises means (6) which implement steps a) to e) of the process specified under claim 1, so as to calculate a force (F) which may be applied to said moveable unit (4), and which determine a control command and transmit it to said actuator (5) so that it applies the force (F) thus calculated to said moveable unit (4).